

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A selected stably reproducing *Papaver somniferum* having an expressed, stable heritable trait of a higher (S)-reticuline than morphine content.
- 5 2. A stably reproducing *Papaver somniferum* according to claim 1, which upon the harvesting of the poppy capsules will yield a poppy straw having a higher (S)-reticuline than morphine content.
3. A stably reproducing *Papaver somniferum* according to claim 1, which upon the collection and drying of the latex from immature poppy capsules will yield an
10 opium having a higher (S)-reticuline to morphine content.
4. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 3~~ in which the production or activity of (S)-reticuline oxidase is inhibited.
5. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 3~~ in which the production or activity of dehydroreticuline reductase is inhibited.
- 15 6. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 3~~ in which the production or activity of berberine bridge enzyme (BBE) is inhibited.
7. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 3~~ in which the production or activity of two or more enzymes selected from the
20 group comprising: (S)-reticuline oxidase, dehydroreticuline reductase or berberine bridge enzyme (BBE) are inhibited.
8. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 7~~,²
which will yield a poppy straw having an (S)-reticuline content greater than

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1.0%, ~~and more preferably greater than 2.5%~~ upon harvesting of the poppy capsules.

9. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 7,~~³
which will yield an opium having an (S)-reticuline content greater than 10%, ~~and~~
5 ~~more preferably greater than 20%~~ upon collection and drying of the latex from
immature poppy capsules.

10. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 9~~
which upon the harvesting of the poppy capsules will yield a poppy straw, an
opium or an extracted alkaloid mixture having an (S)-reticuline to phenanthrene
10 alkaloid ratio of about 100% or greater by weight.

11. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 9~~
which upon the harvesting of the poppy capsules will yield a poppy straw, an
opium or an extracted alkaloid mixture having an (S)-reticuline to phenanthrene
alkaloid ratio of about 200% or greater by weight.

12. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 9~~
15 which upon the harvesting of the poppy capsules will yield a poppy straw, an
opium or an extracted alkaloid mixture having an (S)-reticuline to phenanthrene
alkaloid ratio of about 1250% or greater by weight.

13. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 9~~
20 which upon the harvesting of the poppy capsules will yield a poppy straw, an
opium or an extracted alkaloid mixture having an (S)-reticuline to phenanthrene
alkaloid ratio of up to about 2500% by weight.

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14. A stably reproducing *Papaver somniferum* according to ~~any one of claims 1 to 9~~ which upon the harvesting of the poppy capsules will yield a poppy straw, an opium or an extracted alkaloid mixture having substantially no phenanthrene alkaloid content.
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- 5 15. A seed yielding a stably reproducing *Papaver somniferum* according to ~~any one~~
¹
~~of the preceding claims.~~
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16. Poppy straw of a stably reproducing *Papaver somniferum* ~~according to any one of~~
~~claims 1 to 14~~, the threshed straw having a higher (S)-reticuline than morphine content.
- 10 17. Poppy straw according to claim 16, wherein the (S)-reticuline to phenanthrene alkaloid ratio is 100% or greater by weight.
18. Poppy straw according to claim 16, where in the (S)-reticuline to phenanthrene alkaloid ratio is 200% or greater by weight.
- 15 19. Poppy straw according to claim 16, wherein the (S)-reticuline to phenanthrene alkaloid ratio is 1250% or greater by weight.
20. Poppy straw according to claim 16, wherein the (S)-reticuline to phenanthrene alkaloid ratio is up to 2500% by weight.
21. Poppy straw according to claim 16, having substantially no phenanthrene alkaloid content.
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- 20 22. Poppy straw according to ~~any one of claims 16 to 21~~, having an (S)-reticuline content greater than 1.0%, and more preferably greater than 2.0%.
23. Poppy straw according to claim 22, having an (S)-reticuline content of about 3-4%.

24. Opium of a stably reproducing *Papaver somniferum* ~~according to any one of claims 1 to 14~~, the opium having a higher (S)-reticuline than morphine content.
25. Opium according to claim 24, wherein the opium has an (S)-reticuline to phenanthrene alkaloid ratio of 100% or greater by weight.
- 5 26. Opium according to claim 24, wherein the opium has an (S)-reticuline to phenanthrene alkaloid ratio of 200% or greater by weight.
27. Opium according to claim 24, wherein the opium has an (S)-reticuline to phenanthrene alkaloid ratio of 1250% or greater by weight.
28. Opium according to claim 24, wherein the opium has an (S)-reticuline to phenanthrene alkaloid ratio of up to about 2500% by weight.
- 10 29. Opium according to claim 24, having substantially no phenanthrene alkaloid content.
30. Opium according to ~~any one of claims 24 to 29~~, having an (S)-reticuline content greater than 10%, ~~and more preferably greater than 20%.~~
- 15 31. Extracted alkaloid mixture of a stably reproducing *Papaver somniferum* ~~according to any one of claims 1 to 14~~, the extracted alkaloid mixture having a higher (S)-reticuline than morphine content.
32. Extracted alkaloid mixture according to claim 31, having an (S)-reticuline to phenanthrene alkaloid ratio of 100% or greater by weight.
- 20 33. Extracted alkaloid mixture according to claim 31, have an (S)-reticuline to phenanthrene alkaloid ratio of 200% or greater by weight.
34. Extracted alkaloid mixture according to claim 31, having an (S)-reticuline to phenanthrene alkaloid ratio of 1250% or greater by weight.

35. Extracted alkaloid mixture according to claim 31, having an (S)-reticuline to phenanthrene alkaloid ratio of 2500% or greater by weight.
36. Extracted alkaloid mixture according to claim 31, having substantially no phenanthrene alkaloid content.
- 5 37. Extracted alkaloid mixture according to ~~any one of claims~~ claim 31 to 36, having an (S)-reticuline content greater than 30%, ~~and more preferably greater than 60%.~~
38. A stand of a stably reproducing *Papaver somniferum* ~~according to any one of~~ claims 1 to 14.
39. (S)-reticuline when obtained from a stably reproducing *Papaver somniferum*
10 ~~claim 1~~ according to any one of claims 1 to 14, a poppy straw according to any one of
~~claims 16 to 23, an opium according to any one of claims 24 to 30 or extracted~~
~~alkaloid mixture according to any one of claims 31 to 27.~~
40. A method from the production of (S)-reticuline which comprises the steps of:
- a) harvesting poppy capsules of a selected stably reproducing *Papaver*
15 *somniferum* having an expressed, stable heritable trait of a higher (S)-reticuline than morphine content, to produce a straw having a higher (S)-reticuline than morphine content; and
- b) chemically extracting the (S)-reticuline from the straw.
41. A method for the production of (S)-reticuline which comprises the steps of:
- 20 a) collecting and drying the latex of the immature poppy capsules of a selected stably reproducing *Papaver somniferum* having an expressed, stable heritable trait of a higher (S)-reticuline than morphine content, to produce opium that has a higher (S)-reticuline than morphine content; and

b) chemically extracting the (S)-reticuline from the opium.

42. A method according to claim 40, wherein the stably reproducing *Papaver somniferum* yields a poppy straw having an (S)-reticuline content greater than 1.0%, and more preferably greater than 2.0%.

5 43. A method according to claim 41, wherein the stably reproducing *Papaver somniferum* yields an opium having an (S)-reticuline content greater than 10%_x and more preferably greater than 20%.

44. A method according to ~~any one of claims~~ 40 to 43 wherein the stably reproducing *Papaver somniferum* has an (S)-reticuline to phenanthrene alkaloid content of
10 about 100% or greater by weight.

45. (S)-reticuline when obtained by a method according to any one of claims 40 to 44.

46. A method to improve the (S)-reticuline yield of a stably reproducing *Papaver somniferum*, the method comprises the steps of:

- 15 a) exposing at least one poppy seed of *Papaver somniferum* to a mutagenising agent,
- b) growing the at least one poppy seed to produce a plant bearing a leaf or an immature poppy capsule, optionally through multiple self fertilised generations,
- 20 c) sampling the leaf or poppy capsule for the presence of (S)-reticuline, morphine and codeine, and

- d) repeating steps a) to c) until a poppy plant of *Papaver somniferum* is obtained having a higher (S)-reticuline than morphine content as an expressed, stable heritable trait.

47. A method according to claim 46, wherein steps a) to c) are repeated until the (S)-reticuline content shows no further increase on mutagenesis.

48. A method for the production of (S)-reticuline which comprises the steps of:

- a) harvesting poppy capsules of a selected stably reproducing *Papaver somniferum* having an expressed, stable heritable trait of a higher (S)-reticuline than phenanthrene alkaloid content, to produce a straw having an (S)-reticuline to phenanthrene alkaloid ratio of 100% or greater by weight, and

- b) chemically extracting the (S)-reticuline from the straw.

49. A method for the production of (S)-reticuline which comprises the steps of:

- a) collecting and drying the latex of the immature poppy capsules of a selected stably reproducing *Papaver somniferum* having an expressed, stable heritable trait of a higher (S)-reticuline than phenanthrene alkaloid content, to produce opium having an (S)-reticuline to phenanthrene alkaloid ratio of 100% or greater by weight, and
- b) chemically extracting the (S)-reticuline from the opium.

50. A method to improve the (S)-reticuline yield of a stably reproducing *Papaver somniferum*, the method comprising the steps of:

- a) exposing at least one poppy seed of *Papaver somniferum* to a mutagenising agent,

- b) growing the at least one poppy seed to produce a plant bearing a leaf or an immature poppy capsule, optionally through multiple self fertilised generations,
- c) sampling the leaf or poppy capsule for the presence of (S)-reticuline, morphine and codeine, and
- d) repeating steps a) to c) until a poppy plant of *Papaver somniferum* is obtained having an (S)-reticuline to phenanthrene alkaloid ratio of 100% or greater by weight as an expressed, stable heritable trait.

51. Method for purifying reticuline from an aqueous extract of poppy straw comprising the following steps:

- (i) mixing said extract with toluene at near neutral pH and separating the aqueous and the non-aqueous phases,
- (ii) mixing the aqueous phase from step (i) with toluene at pH of about 9.0 to about 9.4 and separating the aqueous and the non-aqueous phases,
- (iii) extracting reticuline from the non-aqueous phase by caustic extraction.

52. A method according to claim 51, wherein step (i) is repeated before proceeding to step (ii).

53. A method according to ~~claim 51 to~~ claim 52, wherein step (ii) is repeated before proceeding to step (iii).

54. A method according to ~~any one of claims 51 to 53~~, wherein pH in step (i) is about 6.8.

55. A method according to ~~any one of claims 51 to 54~~, wherein pH in step (ii) is about 9.3.

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56. A method according to ~~any one of claims 51 to 55~~, further comprising
- (iv) mixing the caustic extract of step (iii) with toluene at pH of about 8.5 to about 9.5 and separating the aqueous and the non-aqueous phases,
- (v) mixing the non-aqueous phase from (iv) with water at acidic pH, and
- 5 separating the aqueous and the non-aqueous phases,
- (vi) adding alkali to aqueous phase at ambient temperature, ageing for a time sufficient to induce formation of a precipitate and collecting precipitate containing reticuline.
57. A method according to ~~claim 56~~, wherein steps (iv) and/or (v) are repeated.
- 10 58. A method according to claim 56 ~~or claim 57~~, wherein pH in step (iv) is about 9.3.
59. A method according to ~~any one of claims 56 to 58~~, wherein pH in step (v) is about 4.5.
60. A method according to ~~any one of claims 56 to 59~~, wherein alkali is added to achieve a pH of about 9.3.
- 15 61. (S)-reticuline obtained by a method according to ~~any one of claims 51 to 60~~.
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